PIER Energy-Related Environmental Research
Environmental Impacts of Energy Generation, Distribution and Use

Determining How Fish Detect Fish Screens and Testing Potential Fish Screen Enhancements

Contract #: 500-02-004, UC MR-035
Contractor: University of California, Davis
Contract Amount: $71,418
Match Funding: $8,631
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The Issue

The water diversions needed for hydroelectric plants, agriculture, and residential water supply can be lethal to fish—including endangered and threatened species—that become entrained in their influent current. Screens are commonly situated in front of water diversions to prevent fish from being displaced from their habitat, but the protective screens themselves can be fatal if fish contact them severely or repeatedly.

This project will determine the sensory stimuli that different fishes use to recognize the presence and threat of fish screens, and will suggest new screen modifications to improve fish passage.

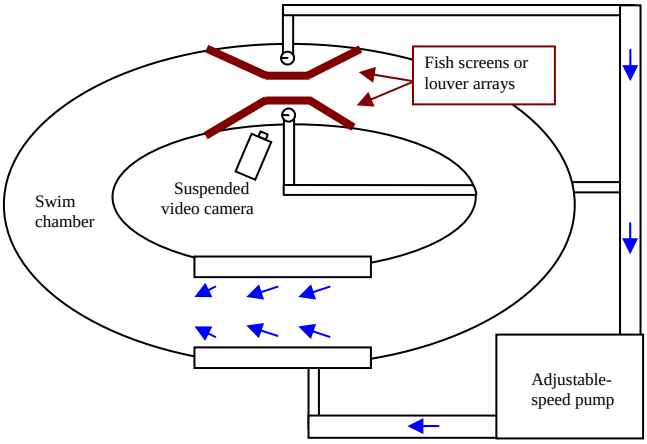

Figure 1. Swim chamber design

Project Description

The study will use captive-reared, native fishes—including juvenile Chinook salmon and steelhead trout—which must pass through habitats where California's water diversions occur. The Central Valley steelhead is a threatened species, and the winter-run Chinook salmon is listed as endangered. This study will use fall-run Chinook salmon.

The first step in the project is to determine if fish rely on vision, mechanoreception (vibration detection via the fish's lateral line system), or a combination of these senses to recognize and avoid fish screens, and to determine the relative importance of each sensory system to avoidance behavior. This will be accomplished through screen avoidance experiments conducted in a loop-shaped swim chamber (Figure 1) where fish will be viewed and recorded as they swim repeatedly past a fish screen. To determine the contribution of vision to screen avoidance, the fish will be tested in both light and dark conditions. To determine the contribution of the lateral line system,

antibiotics will be administered to temporarily block mechanoreception and allow observation of otherwise natural behavior. The treated fish will be compared to the control (untreated) fish to determine the role of mechanoreception in screen avoidance.

Once the utility of the different sensory systems in screen detection is determined for the different species, the research team will attempt to enhance the screen's detectability by increasing the stimuli it generates. Artificial lighting or vibration generators along fish screens might increase fishes' ability to detect screens and recognize them as threatening, and thus provide safer passage.

Tasks include acquiring fish from hatchery programs, determining the effective dose of antibiotics required to block mechanoreception for each species (by looking at its effects on fish hair cells with scanning electron microscopy), building a swim chamber (Figure 1), and conducting comparative swimming studies under various conditions (Table 1).

Table 1. Proposed Experimental Conditions

Treatment Groups	Daytime— Full-Spectrum Illumination	Nighttime— Infrared Illumination
Control (no chemical application)	Normal vision and vibration detection	Impaired vision, normal vibration detection
Antibiotic application	Normal vision, blocked vibration detection	Impaired vision, blocked vibration detection
Increased fish screen illumination		Enhanced visual stimuli, normal vibration detection
Enhanced fish screen vibrations	Normal vision, enhanced vibration stimuli	Impaired vision, enhanced vibration stimuli

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objective:

- **Providing environmentally sound energy.** California's demand for water and electricity is expected to increase in the near future, increasing the threat of entrainment-related losses for many aquatic animals. Fish screens with improved deterrent capabilities will help minimize the impact of water diversions on California's aquatic populations.

Final Report

The final report on the results of this work will be available in the spring of 2006.

Contact

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